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VEGETATION LANDSCAPE MANAGEMENT OF "NATURAL RESERVE OF CHIARONE", MASSACIUCCOLI LAKE BASIN (TUSCANY, IT)

ANDREA BERTACCHI[1], TIZIANA LOMBARDI[1], IACOPO TOMEI[1], MARCELLO LABATE[2], ANDREA FONTANELLI[2], LUCIA PICCHI[2]

[1]Department of Agriculture, Food and Environment (DAFE), University of Pisa, Via del Borghetto 80, 56124 Pisa, Italy;
[2] http://www.oasilipumassaciuccoli.org -Via del Porto 6, loc. Massaciuccoli 55050 Massarosa (LU)

The Massaciuccoli Lake basin is located in NW of Tuscany (Italy) (43°50'N 10°19'E) and it is integral part of the Regional Park of San Rossore, Migliarino and Massaciuccoli (**SIR-pSIC-ZPS n° 25 "Lago e Padule di Massaciuccoli" (IT5120017)**. This endorheic lake and the surrounding marsh-lands, with over 2,000 hectares of surface, form the largest retrodunal wetland of Tuscany. The lake covers about 690 hectares. The origin is probably related to a lagoon lateral of the mouth of the protohistoric Auser river, transformed into a closed basin and isolated from the sea by the advance towards the interior of the dune systems. Currently the lake presents a depth that, in the areas not affected by the quarries, is between 1 and 2.5 m. The average level of the surface of the lake remains for long periods of the year below the marine one.
Over the last century this ecological system has undergone profound changes both because of land drainage, both because of the industrial and agricultural development of the surrounding areas that have heavily polluted lake, whose waters are still affected by serious eutrophication and ecological degradation.

Since the '50s and' 60s the human settlement in the territory of the Massaciuccoli basin has grown in all its forms, since the urban impact due to tourism, particularly in the municipalities of Viareggio and Massarosa and the intense work of mechanical reclamation for the acquisition of farmland, they have a negative impact on the ecosystem, causing a gradual deterioration of water quality.The presence of a large amount of nutrients (N, P, C), show that the lake has undergone a major change going from the clear waters and complex trophic nets are characterized by the presence of submerged macrophytes and zooplankton, to a situation of algal blooms and simpler trophic nets, resulting in the loss of biodiversity.

The characteristic climate of the area is Mediterranean humid and is characterized by average winter temperatures of 7 ° C and summer average of 22 ° C.
The rainfall (800 mm per year) is greater in autumn - winter, coinciding which the waters of the lake reached the highest levels

Fig. 1 Geographic location of study area.

This report shows the results of several years of investigation on the main vegetational types (Tabb. 1- 9) (Phytosociological surveys of vegetation – using Braun-Blanquet method – and floristic detections are carried out in 2014-2015), the presence and distribution of endemic/rare/protected species, the changes on the structure of floating islands of peats and the main actions of conservation and management of these wetlands.

In order to preserve the great natural value of the lake in 1979, with the birth of the regional protected area, was established in the marshy area around the village of Massaciuccoli, the "Natural Reserve of Chiarone"(47 ha of mainland and 53 of lake). Since 1985 the association LIPU (Italian League for Bird Protection) has obtained the management of the reserve, and its activity is directed to purposes of environmental education, environmental restoration, monitoring and conservation of specific habitats.

The lines of the lakeshore are mainly composed of "*aggallati*", ie peat floats of varying thickness and with different types of vegetation. This involves continuous modification of the shore line.

Massaciuccoli lake basin habitats (*sensu Directive 92/43/EEC*) are:
1- Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* H7210*;*
2- Depressions on peat (floating) substrates of the *Rhynchosporion* H7150*;*
3- Mediterranean tall humid herb grasslands of the *Molinio-Holoschoenion* H6420;
4 - Natural euthrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation H3150*;*
5- Natural dystrophic lakes and ponds H3160.

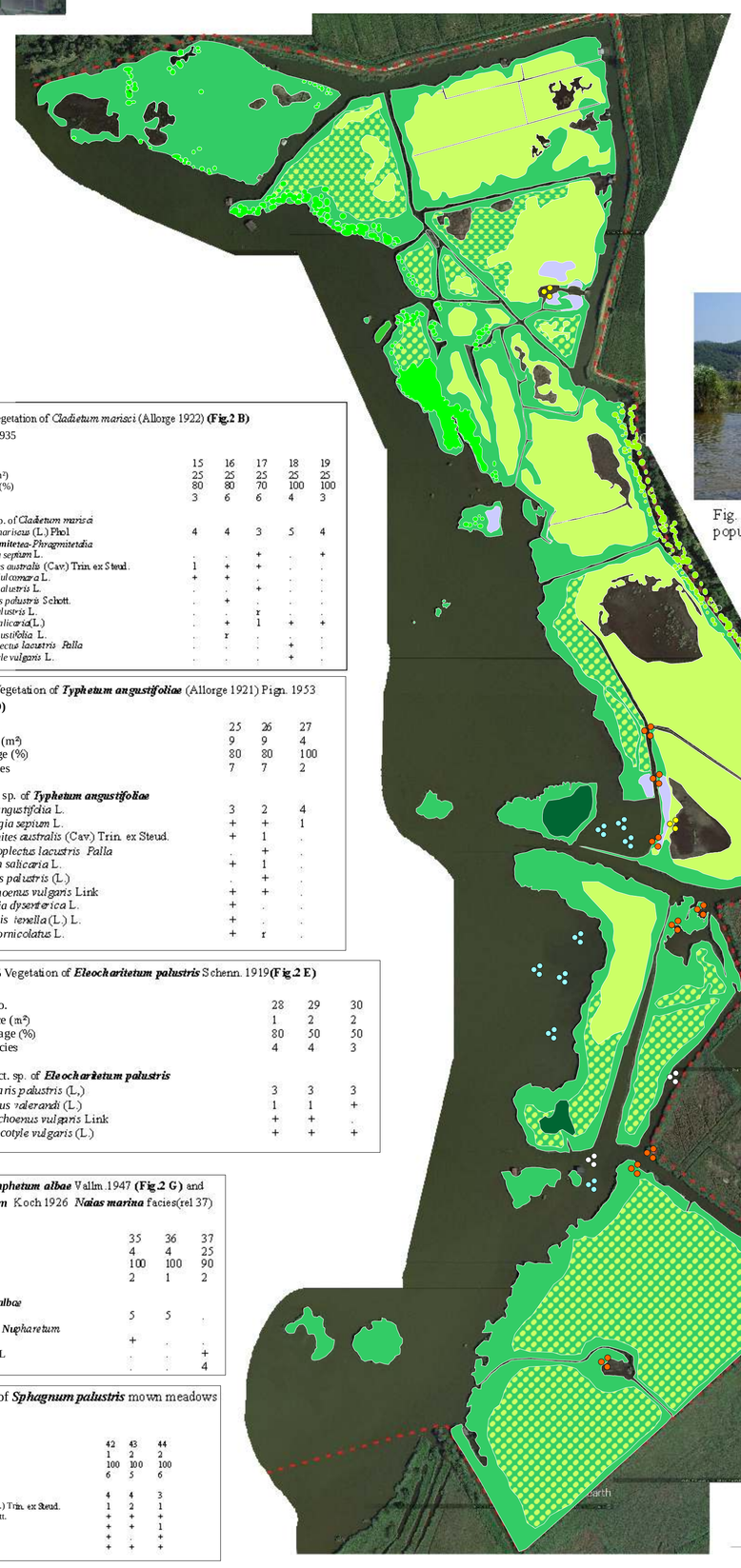

Fig. 2 Map of vegetation landascape

LEGEND OF VEGETATION LANDSCAPE
A
B
C
D
E
F
G
H
I
L
M

Fig. 3 An aspect of landscape vegetation of the reserve: acquatic population of *Najas marina* and *Phragmitetum* on the shore

Tab. 1 Vegetation of ***Phragmitetum australis*** (Gams 1927) Shmale 1939 (**Fig.2 A**)(***Frangula alnus facies*** (rel 13); ***Periploca graeca*** *facies* (rel 14))

Rel. no.	2	6	8	10	12	13	14
Surface (m²)	25	25	25	25	25	25	25
Coverage (%)	100	100	100	100	100	100	100
n° species	10	7	10	12	11	9	7
charact. sp. of ***Phragmitetum australis***							
Phragmites australis (Cav.) Trin. ex Steud.	**4**	5	5	4	4	4	4
sp. ***Phragmitetea-Phragmitetalia***							
Calystegia sepium L.	+	+	+	+	+	+	+
Solanum dulcamara L.	+	.	+	.	+	+	.
Eupatorium cannabinum L.	.	.	.	+	+	+	.
Euphorbia palustris L.	r	.	.	r	.	.	r
Lycopus europeus L.	+	+	.	.	r	r	.
Stachys palustris L.	.	.	r	r	r	.	.
Lythrum salicaria L.	+	.	.	+	+	.	r
Hibiscus palustris L.	r	r	.	.	.	.	.
Typha angustifolia L.	.	r	r	.	.	.	.
Cladium mairicus L.	.	.	.	r	.	r	.
Schoenoplectus lacustris Palla	r	.	.	.	r	.	.
Mentha aquatica L.	.	.	r	.	.	r	.
Osmunda regalis L.	.	.	r	r	.	.	.
Iris pseudacorus L.	1	.	.	+	+	.	.
Oenanthe aquatica L.	.	.	+	.	.	.	+
Hydrocotyle vulgaris L.	.	+	.	.	.	.	r
Hypericon tetrapterum Fr.	.	r	r	+	.	.	.
Lysimachia vulgaris L.	.	.	r	+	+	.	.
sp. ***Alno-Quercion roboris***							
Periploca graeca L.	.	.	.	.	.	+	2
sp. ***Salicion cinereae***							
Frangula alnus Mill.	.	r	.	+	+	2	.
Salix cinerea L.	r	.	.	.	.	+	r

Tab. 3 Vegetation of ***Cladietum marisci*** (Allorge 1922) Zobrist 1935 a ***Phragmites australis facies*** (rel 20)

Rel. no.	20	21	22	23	24
Surface (m²)	25	25	25	25	25
Coverage (%)	80	80	100	80	80
n° species	9	7	7	9	9
charact. sp. of ***Cladietum marisci***					
Cladium mariscus (L.) Phol	3	2	3	3	3
Sp. ***Phragmitetea-Phragmitetalia***					
Phragmites australis (Cav.) Trin. ex Steud.	1	2	2	1	2
Calystegia sepium L.	.	.	+	+	+
Solanum dulcamara L.	.	+	+	.	+
Hibiscus palustris L.	.	+	.	.	r
Thelypteris palustris Schott.	.	.	.	r	r
Lythrum salicaria(L.)	+	+	+	.	+
Typha angustifolia L.	.	.	.	+	.
Schoenoplectus lacustris Palla	+	.	.	+	.
Hydrocotyle vulgaris L.	.	.	.	+	.
Eupatorium cannabinum L.	.	.	r	r	.
Euphorbia palustris L.	r	.	.	.	.
Lycopus europeus L.	.	r	.	.	r
Iris pseudacorus L.	+	+	.	.	.
Oenanthe aquatica L.	.	.	.	r	r
Hydrocotyle vulgaris L.	+	.	.	.	.
Galium palustre L.	+	.	.	.	.
Hypericon tetrapterum Fr.	+	.	r	.	.

Tab. 2 Vegetation of *Cladietum marisci* (Allorge 1922) **(Fig.2 B)** Zobrist 1935

Rel. no.	15	16	17	18	19
Surface (m²)	25	25	25	25	25
Coverage (%)	80	80	70	100	100
n° species	3	6	6	4	3
Charact. sp. of *Cladietum marisci*					
Cladium mariscus (L.) Phol	4	4	3	5	4
Sp. ***Phragmitetea-Phragmitetalia***					
Calystegia sepium L.	.	.	+	.	+
Phragmites australis (Cav.) Trin. ex Steud.	1	+	+	.	.
Solanum dulcamara L.	+	+	.	.	.
Hibiscus palustris L.	.	.	+	.	.
Thelypteris palustris Schott.	.	+	.	.	.
Stachys palustris L.	.	.	r	.	.
Lythrum salicaria(L.)	.	+	1	+	+
Typha angustifolia L.	.	r	.	.	.
Schoenoplectus lacustris Palla	.	.	.	+	.
Hydrocotyle vulgaris L.	.	.	.	+	.

Tab. 4 Vegetation of ***Typhetum angustifoliae*** (Allorge 1921) Pign. 1953 **(Fig.2 D)**

Rel. no.	25	26	27
Surface (m²)	9	9	4
Coverage (%)	80	80	100
n° species	7	7	2
charact. sp. of ***Typhetum angustifoliae***			
Typha angustifolia L.	3	2	4
Calystegia sepium L.	+	+	1
Phragmites australis (Cav) Trin. ex Steud.	+	1	.
Schoenoplectus lacustris Palla	.	+	.
Lythrum salicaria L.	+	1	.
Hibiscus palustris (L.)	.	+	.
Holoschoenus vulgaris Link	+	+	.
Pulicaria dysenterica L.	+	.	.
Anagallis tenella (L.) L.	+	.	.
Lotus cornicolatus L.	+	r	.

Tab. 5 Vegetation of ***Eleocharitetum palustris*** Schenn. 1919**(Fig.2 E)**

Rel. no.	28	29	30
Surface (m²)	1	2	2
Coverage (%)	80	50	50
n° species	4	4	3
Charact. sp. of ***Eleocharitetum palustris***			
Eleocharis palustris (L.)	3	3	3
Samolus valerandi (L.)	1	1	+
Holoschoenus vulgaris Link	+	+	.
Hydrocotyle vulgaris (L.)	+	+	+

Tab. 6 Vegetation of wet meadows **(Fig.2 F)**

Rel. no.	31	32	33	34
Surface (m²)	9	4	9	9
Coverage (%)	50	20	60	20
n° species	10	11	12	10
sp. ***Phragmitetea-Phragmitetalia***				
Phragmites australis (Cav.) Trin. ex Steud.	1	+	1	+
Calystegia sepium L.	+	+	+	+
Pulicaria dysenterica L.	.	r	.	.
Eupatorium cannabinum L.	.	.	.	r
Euphorbia palustris L.	.	.	r	.
Lycopus europeus L.	+	.	.	.
Juncus acutiflorus Ehrh	.	+	+	.
Juncus articulatus L.	r	r	.	.
Carex davilliana? Sm	.	.	.	1
Carex elata All.	+	+	1	+
Lythrum salicaria L.	.	+	+	.
Hibiscus palustris L.	.	r	+	+
Lotus cornicolatus L.	+	.	1	.
Holoschoenus vulgaris Link	+	r	.	.
Schoenoplectus lacustris Palla	+	.	.	.
Mentha aquatica L.	.	.	+	.
Anagallis tenella L.	1	+	+	+
Iris pseudacorus L.	.	r	.	r
Galium palustre L.	+	.	+	+
Lysimachia vulgaris L.	r	.	.	.
Solanum dulcamara L.	.	.	+	+

Tab.7 Vegetation of ***Nymphetum albae*** Vallm.1947 **(Fig.2 G)** and ***Myriophyllo- Nupharetum*** Koch 1926 ***Naias marina*** facies(rel 37) **(Fig.2 H)**

Rel. no.	35	36	37
Surface (m²)	4	4	25
Coverage (%)	100	100	90
n° species	2	1	2
charact. sp. of ***Nymphetum albae***			
Nymphea alba L.	5	5	.
charact. sp. of ***Myriophyllo- Nupharetum***			
Lemna minor L.	+	.	.
Myriophyllum verticillatum L	.	.	+
Naias marina L.	.	.	4

Tab. 9 Vegetation of ***Sphagnum palustris*** mown meadows **(Fig.2 M)**

Rel. no.	42	43	44
Surface (m²)	1	2	2
Coverage (%)	100	100	100
n° species	6	5	6
Sphagnum palustris L.	4	4	3
Phragmites australis (Cav.) Trin. ex Steud.	1	2	1
Thelypteris palustris Schott.	+	+	+
Osmunda regalis L.	+	+	1
Lythrum salicaria L.	+	.	+
Anagallis tenella (L.) L.	+	+	+

Tab.8 Vegetation of wet groves : ***Osmundo regalis-Alnion glutinosae*** (Br.-Bl., P. Silva & Rozeira 1956) Dierschke & Rivas-Martínez in Rivas-Martínez 1975 (rell. 38-39)**(Fig.2 I)**; ***Salicion cinereae*** Müller & Görs 1958 (rell 40, 41)**(Fig.2 L)**

Rel. no.	38	39	40	41
Surface (m²)	100	70	100	70
Coverage (%)	100	100	70	100
n° species	11	11	6	4
sp. ***Osmundo regalis-Alnion glutinosae***				
Alnus glutinosa (L.) Gaertn	4	3	.	.
Osmunda regalis L.	2	1	.	.
Iris pseudacorus L.	+	+	.	.
Carex otrubae Podp.	+	+	.	.
Rubus sppl	1	+	.	.
Calystegia sepium L.	+	+	.	.
Periploca graeca L.	+	+	.	.
Hibiscus palustris L.	.	+	.	.
Galium palustre L.	+	+	.	.
Lysimachia vulgaris L.	+	.	.	.
Solanum dulcamara L.	+	+	.	.
sp. ***Salicion cinereae***				
Frangula alnus Mill.	+	r	r	r
Salix cinerea L.	.	.	1	2
Phragmites australis (Cav.) Trin. ex Steud.	.	.	3	3
Solanum dulcamara L.	.	.	+	.
Thelypteris palustris Schott.	.	.	.	+
Lythrum salicaria L.	.	.	+	.
Typha angustifolia L.	.	.	.	+
Schoenoplectus lacustris Palla	.	.	r	.

The vegetation landscape is mainly formed by a mosaic of *Phragmitetum australis* , *Cladietum marisci* , *Typhetum angustifoliae* , with patches of *Myriophyllo-Nupharetum* , *Nymphetum albae, Eleocharitetum palustris* and a large spread of microwoods of hygrophilous phanerophytes as *Alnus glutinosa, Frangula alnus, Salix* sp.pl.(*Osmundo regalis-Alnion glutinosae, Salicion cinereae*) A particular aspect of this lake environment are the "aggallati", floating islands of peat incurred by intertwining rhizomes of straws.
Above these peatlands often develop communities of *Sphagnum* sp.pl, *Osmunda regalis* L. and *Thelypteris palustris Schott* (Figg. 3,4,5,6,7,8)

Fig. 9 Restore operations of the "aggallato" with *Sphagnum* from the shore by the storms

FLORISTIC LIST (*) rare and protected species L.R. Tuscany 2000 n.56

1. *Alisma plantago-aquatica* L. *Alismataceae*
2. *Alnus glutinosa* L. *Betulacee*
3. *Althaea officinalis* L. *Malvacee*
4. *Anagallis tenella* L. *Myrisinacee* (*)
5. *Arundo donax* L. *Poaceae*
6. *Calystegia sepium* L. *Ranuncolaceae*
7. *Carex davalliana* Sm. *Cyperaceae* (*)
8. *Carex elata* All. *Cyperaceae* (*)
9. *Carex paniculata* L. *Cyperaceae* (*)
10. *Carex otrubae* Podp. *Cyperaceae*
11. *Cirsium palustris* L. *Asteraceae*
12. *Cladium mariscus* L. *Cyperaceae* (*)
13. *Echinocloa crus-galli* L. *Beauv. Poaceae*
14. *Elocharis palustris* (L.) Roem & Schult *Cyperaceae* (*)
15. *Eupatorium cannabinum* L. *Asteracce*
16. *Euphorbia palustris* L. *Euphorbiaceae* (*)
17. *Frangula alnus* L. *Rhamnacee* (*)
18. *Galium palustre* L. *Rubiaceae* (*)
19. *Holoschoenus vulgaris* Link *Cyperaceae*
20. *Hibiscus palustris* L. *Malvaceae* (*)
21. *Hypericon tetrapterum* Fries *Hypericaceae*
22. *Hydrocotyle vulgaris* L. *Araliaceae*
23. *Iris pseudacorus* L. *Iridaceae*
24. *Juncus acutiflorus* Ehrh *Juncaceae*
25. *Juncus articulatus* L. *Juncaceae*
26. *Lemma minor* L. *Lemnaceae*
27. *Lotus cornicolatus* L. *Fabaceae*
28. *Lythrum salicaria* L. *Lythraceae*
29. *Lysmachia vulgaris* L. *Myrsinaceae*
30. *Lycopus europeus* L. *Lamiaceae*
31. *Myriophyllum spicatum* L. *Haloragaceae* (*)
32. *Myriophyllum verticillatum* L. *Haloragaceae* (*)
33. *Mentha aquatica* L. *Lamiaceae*
34. *Najas marina* L. *Hydrocharitaceae* (*)
35. *Nynphaea alba* L. *Nynpheaceae* (*)
36. *Oenanthe aquatica* L. *Apiaceae* (*)
37. *Oenanthe silaifolia* M.Bieb. *Apiaceae*
38. *Osmunda regalis* L. *Osmundaceae* (*)
39. *Periploca graeca* L. *Aponycaceae* (*)
40. *Phragmites australis* (Cav.) Trin *Poaceae*
41. *Peucedanum palustre* (L.) Moench *Apiaceae*
42. *Populus alba* L. *Salicaceae*
43. *Polygonum amphibium* L. *Polygonaceae*
44. *Potamogeton pectinatus* L. *Potamogetonaceae*
45. *Pulicaria dysenterica* L. Berhn *Asteraceae*
46. *Ranunculs aquatilis* L. *Ranuncolaceae*
47. *Rubus* sppl. *Rosaceae*
48. *Samolus valerandi* L. *Samolaceae*
49. *Salix alba* L. *Salicaceae*
50. *Salix cinerea* L. *Salicaceae*
51. *Schoenoplectus tabernaemontani* (Gmelin) Palla *Cyperaceae*
52. *Schoenoplectus lacustris* Palla *Cyperaceae*
53. *Solanum dulcamara* L. *Solanaceae;*
54. *Stachys palustris* L. *Lamiaceae* (*)
55. *Sphagnum palustre* L. *Sphagnaceae*;
56. *Thelypteris palustris* Schott *Thelypteridaceae* (*)
57. *Typha angustifolia* L. *Typhaceae*

Fig. 4 *Phragmitetum* in the foreground and *Cladietum* in the background

Fig. 5 *Eleocharicetum palustris*

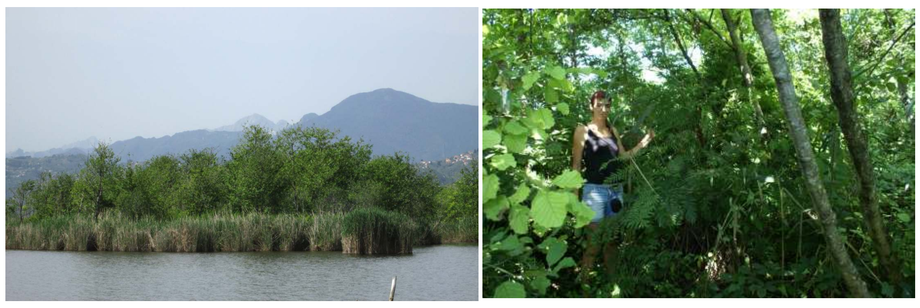

Fig. 6 Vegetation of wet groves : *Osmundo regalis-Alnion glutinosae*

Fig.7 Vegetation of *Nymphetum albae*

Fig. 8 Vegetation of *Typhetum angustifoliae*

Fig. 10 Mowing of *Sphagnum* meadows

Fig. 11 *Sphagnum* meadows in spring

Fig. 12 *Sphagnum palustre* and *Osmunda regalis* meadows

Fig. 13 A "chiaro" after mowing.

The actions of environmental management within the Reserve, scheduled through the five-year management plans, are aimed at the maintenance of an adequate level of environmental heterogeneity (presence of "canneti" and "falascheti", "chiari" wet meadows, alder woods), the conservation of specific biological communities (ie *Sphagnum* meadows) (Figg. 10, 11, 12) or particularly rare species and are mainly functional requirements related to human use and accessibility for birds.
The "chiari" are water mirrors vegetation free with varying depth between 0 and 30 cm and are obtained by mowing, in the appropriate season, the *C.mariscus*. They are of great importance for the nesting of some birds. In 1998 there were no "chiari" within the Reserve since then have been realized three: two in the area covered by the trenches (1999 and 2001) (Fig 13) and one at the south of the Reserve (2011) (Fig. 13).
From 2011 due to heavy grazing nutria, concomitant with an unusually high water levels during the summer, the density of sedge in the north of the reserve began to decrease until the appearance of a large "chiaro" and some more small.
The wet meadows habitats are quite rare in the reservoir lake due to the hike of the water levels, but are also very important areas because they support a wide floristic diversity and they are rest and nesting areas for different species of small waders and passerines. The areas of floating marsh recreate the physical conditions of the wet meadows, but on the other hand require frequent maintenance (3-4 mowings per year) to prevent the growth of helophytes.The *Sphagnum* meadows covers an area of about 5,000 sqm within an "aggallato", the management is to complete helophytes mowing and removal of the cut material once a year in February and began in 1998.
The smaller channels need of interventions of cleaning at the end of the summer season to prevent the closure. In two cases, has also been performed the excavation of two channels that were buried.
The floating islands ("aggallati") that surrounded almost completely the area of Chiarone and the surrounding areas along the eastern shore of the lake were the result of a man management aimed at hunting and exploitation of land resources: the islands carried by wind were blocked are planted the poles that held him. The abandonment of the management and intense weather events have resulted in the time the detachment and the loss of numerous islands also widespread (Fig. 9). The objective is to keep the existing and to restore, as far as possible that which was lost.

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